

# Assessment of the Inquiry Teaching Method on Academic Achievements of Students in Biology Education at Mawuko Girls School, Ho, Ghana

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**Abstract** The study assessed the inquiry method on students' academic achievement in biology in Mawuko Girls School in Ho Municipality using quasi-experimental pre-test and post-test non-equivalent control group design. It employed lecture teaching method as a control to established the variation between the lecture teaching method and that of inquiry. Second-year students offering biology were used for the study. Two research questions and two hypotheses were tested at 5% level of significance. The sample size of the study was 101 second-year biology students drawn by purposive sampling technique from the school. The classes used for the study were selected by simple random sampling using the ballot method. Mean, grand mean, standard deviation and t-test statistic were used to analyze data from the result of a Researcher Made Biology Test (RMBT) used for data collection. The results show that there was a significant difference between the achievements of students taught with the inquiry method and those taught with lecture method in favour of inquiry ( $p \leq 0.05$ ). There was, however, no statistically significant difference between the mean pretest scores of the experimental and control groups used for the study ( $p > 0.05$ ). The mean post-test scores show a wide difference. Inquiry method proved more effective than lecture method in enhancing students' academic achievement in biology. Workshops, seminars and refresher courses on inquiry teaching and learning are therefore recommended for teachers and educational instructors to build their competency levels. Also, laboratories, as well as other infrastructure that supports inquiry learning, should be made available to the school.

**Keywords:** *inquiry teaching method, lecture method, biology teaching, good laboratories, students*

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## 1. Introduction

Biology is the study of living things [1]. It helps learners to have insight on natural and environmental concepts, principles, theories, and laws. Among others, the objectives of teaching biology at secondary school level involve the ability of the learners to develop an awareness of the environment, to have meaningful and relevant knowledge in biology necessary for successful living in a scientific and technological world and to make room for technological advancement. Additionally, knowledge of biology is a requirement for many fields of study that have an immense contribution to the technological growth of the nation [2]. These are, but not limited to, medicine, laboratory sciences, pharmacy, nursing, physiotherapy,

agriculture among others [3]. Hence, the introduction of biology to senior secondary school students is a crucial step towards grooming them for a successful career [4]. It is, therefore, important that schools should have an adequate number of trained and qualified biology educators to teach this subject [5]. Unfortunately, this is far from the case as there are limited trained and qualified teachers to take up this task. Educational administrators and planners are therefore beginning to show an increased awareness of the importance of the way students learn. This is because a good number of the standard methods of teaching have proven to be less effective on the students' ability to understand and to retain salient concepts [1]. Indeed, the lecture method of teaching has been the oldest instructional method employed by teachers. Thus, students' participation in this teaching method is just to pay attention and make notes where necessary. The lecture

method does not promote in-depth thinking, creativity, and collaborative problem-solving [6]. Also, students lose interest easily during lectures and information tends to be forgotten quickly when students are passive. It is now being realized that there are more appropriate ways of teaching and learning than through the lecture method [7]. As far back as 2002, recommendations on the need to implement inquiry-based teaching approach were made. It was based on the fact that it emerged from the research of several educational planners [8]. Again, Biology educators believed that the inquiry-based teaching approach encouraged active students' participation, critical thinking and analytical problem solving compared to the lecture teaching method [9]. However, [10] further suggested that the inquiry-based classroom requires building an environment like the scientists' work. In their explanation, they highlighted the fact that students should be guided to take action as scientists do, experiencing the process of acquiring knowledge and justifying it. This approach of teaching, therefore, appeared to be more preferred especially in our quest to grow technological as a country. In spite of the several recommendations that have been made for the implementation of inquiry teaching method in biology education, it has become increasingly difficult for teachers to utilize it. As of 2015, teachers still utilized the traditional lecture teaching method. According to [11], some of the reasons include laboratory inadequacy, teachers' attitude and the lack of a serene and enabling environment. Additionally, the lack of constant feedback is a critical factor that affects students' academic performance. One of the ways of getting feedback is through the assessment of students. The assessment could be summative or formative. Summative assessment is the most widely used in biology education [12]. It is helpful in measuring students' knowledge at the end of a unit, for promotion and for certification. Biology teachers utilizing formative assessment methods are able to meet various students' needs through differentiation and adaptation of teaching to raise levels of student achievement and to achieve a greater equity of student outcomes [13]. Regular employment of formative assessment throughout various systems of education may assist stakeholders to solve the very problem to its wider practice in various settings. That notwithstanding, the combination of formative and summative assessment together with suitable teaching methods theoretically shows so much promise in achieving success in biology teaching and learning. This study, therefore, seeks to employ these assessment tools in evaluating the academic achievement in Biology of students in Mawuko Girls School based on the inquiry teaching approach with the lecture teaching methods as a control. Though various researches have emphasized the importance of inquiring in the science process, the academic achievement of Ghanaian students in Biology at West African Senior School Certificate Examination (WASSCE) level has consistently remained poor [14]. The situation in Mawuko Girls is not different. This phenomenon has become a great source of worry for students, parents, teachers and educational planners. Additionally, this trend raises a lot of questions and eyebrows as to whether inquiry learning enhances academic achievements. Of more importance is whether the teachers are using the inquiry method of teaching or

using traditional methods. Various reports have suggested the traditional lecture method as the common teaching strategy for biology education whilst others have suggested inquiry. Regardless of the teaching approach employed, there is the need to turn the academic fortunes of biology students in secondary schools in Ghana around. This study, therefore, sought to assess the academic achievement of students in biology education in Mawuko Girls School with respect to inquiry teaching method. Specifically, the study sought to assess the mean; Pre-test scores of experimental and control groups used for the study and Post-test scores of students taught with the inquiry method against controls (lecture method).

### 1.1. Hypotheses

HO<sub>1</sub>: There is no significant difference between the mean pre-test scores of experimental and control groups used for the study.

HO<sub>2</sub>: There is no significant difference between the mean post-test scores of students taught with inquiry method and those taught with the lecture method.

## 2. Materials and Method

The study adopted the quasi-experimental pre-test, post-test non-equivalent control group design. The study population was second-year students offering biology in Mawuko Girls School. The sample for the study consisted of 101 drawn from second-year biology students from Mawuko Girls School in Ho Municipality. The study adopted purposive sampling technique to select classes that offer biology as an elective subject. The participants in the intact classes were randomly assigned to experimental and control group. The experimental group was the inquiry method while the control group was the lecture method. Data collection was done with the help of a Researcher Made Biology Test (RMBT). Specifically, the questions were drawn from Cell I as well as Mammals I & II of the biology syllabus. The RMBT was used for both pre-test and post-test. This comprised 30 items of multiple choice objective tests. Each objective question had 4 options A, B, C, and D; with one correct answer to be chosen from. This test was designed to measure students' cognitive achievement in cell and mammals lesson. Administration of pre-test was done in the first week of the research exercise to both the experimental and control groups prior to the treatment. The treatment was done strictly on selected topics drawn from senior secondary school II syllabi which included: The cell, the experimental group was taught with the inquiry method, while the control group was taught using the lecture method. The class teaching was done by the researcher. A total of 5 lesson periods were used. Each lesson period lasted for 40 minutes.

At the end of the lesson, the post-test was administered to the students. The researcher marked and recorded the scores. The teachers helped in distributing the instrument and answer sheets to the students. They also supervised the students and collected the answer sheets at the end of the test. Pre-test and Post-test results from the Researcher Made Biology Test (RMBT) was checked and entered

into Microsoft Excel software. The compiled data were analyzed using STATA version 15.0. The research questions were answered using tables generated for Mean and standard deviation with regards to pre-test and post-test. The hypotheses were tested at 5% level of significance using t-test statistic.

### 2.1. Quality Control and Assurance

Two experts in Science Education (Biology) from SDA College of Education, Koforidua, and University of Health and Allied Sciences validated the instruments (RMBT) and the lesson plan and made amendments where necessary in terms of content coverage of items and use of expressions to avoid ambiguity. After making corrections from the validators, the instruments were found to have both content and face validity and were used for the study. When external teachers were involved in the experiments, the students become sensitized that they are being used for a study. Consequently, they tend to behave mechanically, faking most of their actions. This introduces bias. In order to avoid bias in this study, the regular Biology teachers in each of the schools used for the study were trained in how to use the media. The researcher monitored these teachers to ensure that they effectively adhered to instructions. Homogeneity of instruction across groups was ensured using the following standards; teachers were given a minimum amount of training on instructional procedures, teachers were directed to strictly follow the detailed lesson note provided and experimental and control groups were taught the same topics within the regular periods allocated to biology in the school timetable using their respective teaching methods.

### 3. Results and Discussions

The results in Table 1 represent the mean pretest scores of experimental and control groups. Fifty-one students

representing the experimental group had a mean score of 15.10. Fifty-one (51) students representing the control group had a mean of 17.02. The results show that the two groups have relatively equal scores. This implies that the two groups were of approximately equal academic background.

Table 2 represents the comparison of the experimental and control groups with respect to their mean pretest scores. Since the t-calculated is less than t-critical at 0.05 level of significance. We fail to reject the null hypothesis (HO<sub>1</sub>). These results confirm that the experimental group and control groups have an equal academic background.

Table 3 shows the mean post-test scores of students of students taught with inquiry and lecture teaching methods. Fifty-one (51) students who represented the experimental group were taught with the inquiry method. A mean of 27.19 was obtained among this group. Further, equal numbers representing the control group were treated with the traditional lecture method. A markedly wide difference in mean scores was observed between the students taught with inquiry method and those with the lecture method.

Table 4 shows that the t-test analysis of mean post-test scores of students taught with an inquiry as well as those taught with the traditional lecture method. The study observed that t-calculated is greater than the t-critical at 0.05 level of significance. The null hypothesis (HO<sub>2</sub>) is therefore rejected because there is a significant difference between them. The significant difference suggests that the students taught with the inquiry method performed better than those taught with the traditional lecture method.

Table 1. Mean Pretest result of Experimental and Control Groups

Groups	N	Mean ± SD
Experimental Group	51	17.10 ± 1.47
Control Group	51	17.02 ± 1.42

N = number of participants.

Table 2. T-Test Analysis of Mean Pretest Scores of Experimental and Control Groups

Groups	Grand Mean	Standard Deviation	N	DF	Standard Error	t-calc	t-crit.
Experimental Group	17.10	1.47	51	50	0.041	1.936	1.96
Control Group	17.02	1.42	51	1			

N = number of participants; DF= Degree of freedom; t-calc = t calculated; t-crit = t critical.

Table 3. Post-Test Result of Students Taught with Inquiry Method and Those Taught with Lecture Method

Groups	N	Mean±SD
Students taught with inquiry method (experimental group)	51	27.19 ± 2.60
Students taught with lecture method (control group)	51	17.60 ± 2.37

N = Number of participants.

Table 4. T-Test Analysis of Mean Post Test Scores of Students Taught with Inquiry and Those Taught with Lecture Method

Groups	Grand Mean	SD	N	DF	Standard Error	t-calc	t-crit
Students taught with inquiry method	27.19	2.60	51	50	0.457	20.98	1.96
Students taught with lecture method	17.60	2.37	51	1			

SD = Standard deviation; N = Number of participants; DF= Degree of freedom; t-calc= t-calculated; t-crit = t-critical.

### 3.1. Discussions

The results of the study revealed that the experimental and control groups of students did not perform better than one another at the pretest level. This outcome was quite obvious because the two groups had not been exposed to any instructional method before the test. Furthermore, measures were put in place to ensure that the two groups do not outperform each other. Such measures were targeted at taking care of initial group differences as well as other factors that have the ability to cause variations in their pretest results. Also at the post-test level, the result of the study revealed that the inquiry group of students performed significantly better than the traditional lecture group of students. Additionally, it was also observed that students also showed a keen interest in the inquiry method. This owes to the fact that it granted them the opportunity to think and also develop concepts based on their own observation, experimentation, and research. These findings are consistent and complementary with the several types of research [14,15,16,17]. These agree that students learn more and better when they are actively involved in the learning process. Practicing teachers have suggested that facts obtained by students. The findings of the study are however in contradiction with that of [18]. Her study on, "traditional lecture versus an activity approach for teaching statistics" rather found no statistical difference in the two teaching approaches. The study was however quick to suggest the likelihood of confounding variables contributing to the phenomenon and study outcome. Again, the differences in areas of interest of their research and this current study may have contributed to the study outcome. Statistics and Biology are two different subject areas. Therefore, may require varying teaching approaches and methods. Whilst there are limitations regarding confounders to the research findings of [18], there is some reason to support her position. Ghana Education Service has suggested that secondary schools in Ghana use the inquiry teaching method. This is supposed to be achieved through their implementation of laboratory experimentations in the Biology curriculum. Meanwhile, the academic achievement of students in Biology in WASSCE has consistently been poor. This may support her assertion that lecture and inquiry method are not better than each other.

The findings of the research leave us with a lot of questions. If teachers of the institution actually utilize the inquiry method suggested by the Ghana Education Service (G.E.S), why are the students' performances in biology still low? There are therefore two answers that best satisfies the question. Various schools of thoughts have suggested that several secondary schools in the sub-Saharan region still use the traditional lecture method for teaching biology. There is a reason to believe that the teachers of Mawuko Girls School may also be utilizing this instructional method. On the other hand, it is also possible that the method of instruction may be the inquiry method but it is not appropriately administered. Inquiry method generally is stressful and time consuming compared to the traditional lecture method. This makes it a less comfortable option for teachers and instructors to utilize it

fully. Findings of [19] suggest that science teachers administer lessons without performing experiments. They also do not engage students in discussions that demand critical thinking and problem-solving. Additionally, students sometimes observe things, record observations made, analyze data and make deductions, perform experiments, put things into different classes/groups, interpret data by using charts and graphs, carry out activities again when results are doubtful, and discuss results obtained with other members of the class, but students do not take measurements of things, identify problems, neither did they formulate hypotheses nor question the results of activities.

Lastly, it was also observed that an amalgamation of formative and summative assessments plays a key role in academic achievement in Biology education. They are helpful in providing necessary feedback that helps in bringing students on track to academic excellence in case they lag behind.

#### 3.1.1. Summary of Findings

The issue of poor academic performance of students in Biology in external examinations is a great source of worry to the nation. The study was therefore carried out to assess the academic achievement of biology students in Mawuko Girls School based on two teaching methods, inquiry and lecture methods. Out of the two teaching and instructional methods, inquiry method emerged as a better method with regards to students' academic achievement and ability to retain important concepts. Furthermore, the inquiry method proved to enhance students' ability to be innovative and to think outside the box. The major question that still remains is why students perform poorly in biology in secondary schools. In answering this question, the researcher believes that the school still uses the lecture method due to the stressful nature of the inquiry method of teaching and also due to logistical constraints.

## 4. Conclusions

The following were concluded based on the results obtained from the study

- Teaching methods have a significant effect on students' interest in biology
- Inquiry method of teaching is better than lecture method with respect to students' academic achievement.

## 5. Recommendations

- Biology teachers are advised to seriously consider the use of the inquiry method of teaching since it enhances students' academic achievement in biology
- Biology teachers should consider eliminating the use of the traditional lecture method of teaching. This is because it does not help students' in understanding and retaining relevant concepts
- Teachers advised to be tolerant in using the inquiry method because it is time and energy intensive specially to obtain maximum results

- Teachers should be engaged in workshops, seminars and refresher courses on how to use the inquiry method of teaching
- Government should consider providing adequate facilities for the teaching and learning of biology. This is because the inquiry teaching method is practical oriented and requires the utilization of adequate instructional methods.

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